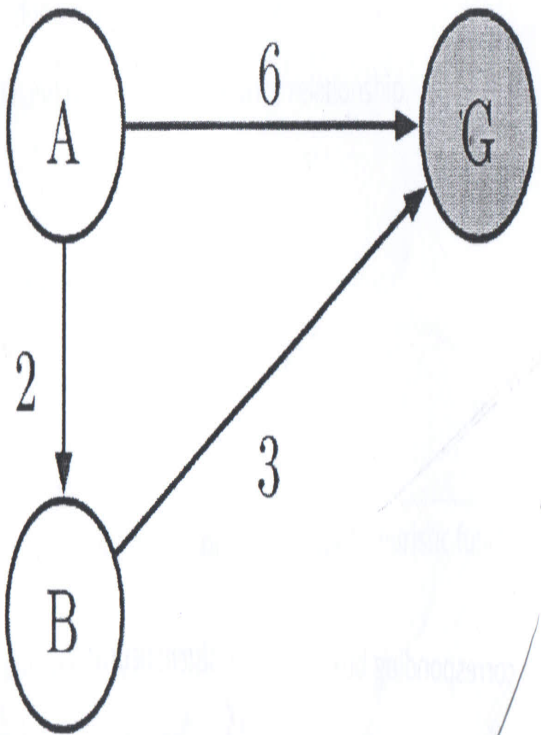
PROBLEM 2: SEARCH: HEURISTIC FUNCTION PROPERTIES

For the following questions, consider the search problem shown in the figure below. It has only three states, and three directed edges. A is the start node and G is the goal node. In the table below, four different heuristic functions are defined, numbered I through IV.



	$h(A)$	$h(B)$	$h(G)$
I	4	1	0
II	5	4	0

III	4	3	0
IV	5	2	0

PART 1: ADMISSIBILITY AND CONSISTENCY

PART 1.1 (2 points possible)

For each heuristic function below, check the corresponding box if it is an *admissible* heuristic.

- [x] I
- [ ] II
- [x] III
- [x] IV

Hide Answer *You have used 0 of 1 submissions*

PART 1.2 (2 points possible)

For each heuristic function below, check the corresponding box if it is a *consistent* heuristic.

- [ ] I
- [ ] II
- [x] III
- [ ] IV

Hide Answer *You have used 0 of 1 submissions*

PART 2: FUNCTION DOMINATION

Recall that *domination* has a specific meaning when talking about heuristic functions.

PART 2.1 (1 point possible)

Which one of the following statements about the relationship between heuristic functions III and IV is true?

- Heuristic function III dominates IV.
- Heuristic function IV dominates III.
- Heuristic functions III and IV have no dominance relationship. ✔

Hide Answer *You have used 0 of 1 submissions*

Help

PART 2.2 (1 point possible)

Which one of the following statements about the relationship between heuristic functions I and IV is true?

- Heuristic function I dominates IV.
- Heuristic function IV dominates I. ✔
- Heuristic functions I and IV have no dominance relationship.

Hide Answer *You have used 0 of 1 submissions*

PROBLEM 3: CSP TIME MANAGEMENT

Two of our TAs, Arjun and Peter, are making their schedules for a busy morning. There are five tasks to be carried out:

- (F) Pick up food for the group's research seminar, which, sadly, takes one precious hour.
- (H) Prepare homework questions, which takes 2 consecutive hours.
- (P) Prepare the PR2 (robot that Pieter uses for research) for a group of preschoolers' visit, which takes one hour.
- (S) Lead the research seminar, which takes one hour.
- (T) Teach the preschoolers about the PR2 robot, which takes 2 consecutive hours.

The schedule consists of one-hour slots: 8am-9am, 9am-10am, 10am-11am, 11am-12pm. The requirements for the schedule are as follows:

a. In any given time slot each TA can do at most one task (F, H, P, S, T).

b. The PR2 preparation (P) should happen before teaching the preschoolers (T).

c. The food should be picked up (F) before the seminar (S).

d. The seminar (S) should be finished by 10am.

e. Arjun is going to deal with food pick up (F) since he has a car.

f. The TA not leading the seminar (S) should still attend, and hence cannot perform another task (F, T, P, H) during the seminar.

g. The seminar (S) leader does not teach the preschoolers (T).

h. The TA who teaches the preschoolers (T) must also prepare the PR2 robot (P).

i. Preparing homework questions (H) takes 2 consecutive hours, and hence should start at or before 10am.

j. Teaching the preschoolers (T) takes 2 consecutive hours, and hence should start at or before 10am.

Keep Constraints Always Visible

ormalize this problem as a CSP, use the variables F, H, P, S and T. The values they take on indicate the TA responsible for it, and the starting time slot during which the task is carried out (for a task that spans 2 hours, the variable represents the starting time, but keep in mind that the TA will be occupied for the next hour also - make sure you enforce constraint (a)!). Hence there are eight possible values for each variable, which we will denote by A1, A2, A3, A4, P1, P2, P3, P4, where the letter corresponds to the TA and the number corresponds to the time slot. For example, assigning the value of A1 to a variables means that this task is carried about by Arjun from 8am to 9am.

We recommend you work out the solutions to the following questions on a sheet of scratch paper, and then enter your results below.

PART 1 (1 point possible)

What is the size of the state space for this CSP?

- \(40\)
- \(13\)
- \(5^8\)
- \(8^5\) ✔
- \(2^5\)
- \(2^8\)

Hide Answer *You have used 0 of 1 submissions*

PART 2 (1 point possible)

Which of the statements above include unary constraints?

- [ ] a
- [ ] b
- [ ] c
- [ ] d ✔
- [ ] e ✔
- [ ] f
- [ ] g

- [ ] h
- [x] i
- [x] j

Hide Answer *You have used 0 of 2 submissions*

PART 3 (3 points possible)

Check all remaining values after enforcing all unary constraints.

F	H	P	S	T
A1 ✓	A1 ✓	A1 ✓	A1 ✓	A1 ✓
A2 ✓	A2 ✓	A2 ✓	A2 ✓	A2 ✓
A3 ✓	A3 ✓	A3 ✓	A3	A3 ✓
A4 ✓	A4	A4 ✓	A4	A4
P1	P1 ✓	P1 ✓	P1 ✓	P1 ✓
P2	P2 ✓	P2 ✓	P2 ✓	P2 ✓
P3	P3 ✓	P3 ✓	P3	P3 ✓
P4	P4	P4 ✓	P4	P4

Help

Hide Answer *You have used 0 of 2 submissions*

PART 4 (3 points possible)

Start from the table above, select the variable S and assign the value A2 to it. Check all remaining values below after performing forward checking.

F	H	P	S	T
A1 ✓	A1	A1 ✓	A1	A1
A2	A2	A2	A2 ✓	A2

A3	A3 ✓	A3 ✓	A3	A3
A4	A4	A4 ✓	A4	A4
P1	P1	P1 ✓	P1	P1
P2	P2	P2	P2	P2
P3	P3 ✓	P3 ✓	P3	P3 ✓
P4	P4	P4 ✓	P4	P4

Hide Answer *You have used 0 of 2 submissions*

PART 5 (1 point possible)

Based on the result of Part 4, what variable will we choose to assign next based on the MRV heuristic (breaking ties alphabetically)?

- F ✓
- H
- P
- S
- T

Hide Answer *You have used 0 of 1 submissions*

PART 6 (3 points possible)

Assign the first possible value to the variable chosen in Part 5, then perform forward checking. Check all remaing values left below.

F	H	P	S	T
A1 ✓	A1	A1	A1	A1
A2	A2	A2	A2 ✓	A2
A3	A3 ✓	A3 ✓	A3	A3

A4	A4	A4 ✔	A4	A4
P1	P1	P1 ✔	P1	P1
P2	P2	P2	P2	P2
P3	P3 ✔	P3 ✔	P3	P3 ✔
P4	P4	P4 ✔	P4	P4

Hide Answer *You have used 0 of 2 submissions*

PART 7 (1 point possible)

Have we arrived at a dead end (i.e., have any of the domains become empty?

- Yes
- No ✔

Hide Answer *You have used 0 of 1 submissions*

PART 8 (4 points possible)

We return to the result from enforcing just the unary constraints, which we did in Part 3. Select the variable S and assign the value A2. Enforce arc consistency, then check all remaining values below.

F	H	P	S	T
A1 ✔	A1	A1	A1	A1
A2	A2	A2	A2 ✔	A2
A3	A3 ✔	A3	A3	A3
A4	A4	A4	A4	A4
P1	P1	P1 ✔	P1	P1
P2	P2	P2	P2	P2

P3	P3	P3	P3	P3 ✔
P4	P4	P4	P4	P4

Hide Answer *You have used 0 of 2 submissions*

PART 9 (1 point possible)

Compare your answers from Part 6 and Part 8. Which of the following statements explains the difference between the two sets of domains?

- Forward checking removes more values than arc consistency because forward checking checks consistency between any pair of variables, while arc consistency only checks relationships between pairs of assigned and unassigned variables.
- Arc consistency removes more values than forward checking because arc consistency checks consistency between any pair of variables, while forward checking only checks relationships between pairs of assigned and unassigned variables. ✔

Hide Answer *You have used 0 of 1 submissions*

PART 10 (2 points possible)

Examine your answer to Part 8. Without backtracking, does any solution exist along this path in the search tree? If so, mark the solution below. If there is no solution, leave all checkboxes unchecked.

F	H	P	S	T
A1 ✔	A1	A1	A1	A1
A2	A2	A2	A2 ✔	A2
A3	A3 ✔	A3	A3	A3
A4	A4	A4	A4	A4
P1	P1	P1 ✔	P1	P1
P2	P2	P2	P2	P2
P3	P3	P3	P3	P3 ✔
P4	P4	P4	P4	P4